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From: Kevin Whitney
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Subject: Southwest Research Institute (SwRI®) Proposal 03-52203, SwRI Response to NREL RFP Number RCI-8-88613, "EPAct Comprehensive Light-Duty Gasoline Vehicle Exhaust Fuel Effects Test Program –Phases 1 and 2"

1.0 INTRODUCTION

The National Renewable Energy Laboratory's (NREL's) Health Impacts Program, in support of the U.S. Department of Energy Office of Heavy Vehicle Technologies, is responsible for quantifying the effects of new vehicle technologies, fuels, and lubricants on air quality and human health. This work effort is the first of a three-part project that is designed to investigate the influence of different fuel compositions on light-duty gasoline vehicle emissions.

Section 1506 of the Energy Policy Act of 2005 (EPAct) requires the U.S. Environmental Protection Agency (EPA) to produce an updated fuel effects model representing the 2007 light-duty gasoline fleet, including determination of the emissions impacts of increased renewable fuel use.

The use of ethanol in gasoline has increased more than five-fold since 2000, and it is likely that its use will continue to expand into the next decade. It is also likely that use of ethanol blends at 10% or greater will expand significantly.

Recent investigation related to the Mobile Source Air Toxics (MSAT2) rulemaking has shown that hydrocarbon emissions from light-duty gasoline vehicles increase significantly as test temperature is decreased, and that those emissions change as a function of ethanol content in gasoline. As a result, the MSAT2 rulemaking promulgated non-methane hydrocarbons (NMHC) standards at 20°F. However, as this is a relatively new area of study, fuel effects data at temperatures lower than 75°F are scarce for use in emissions models.



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Hydrocarbon (HC) emissions are composed of hundreds of compounds, some of which have been identified by the EPA as air toxics. The Clean Air Act directs EPA to set standards to reduce air toxics emissions. Most existing data on the fractional relationship between the various air toxics and HC emissions have been established using vehicles meeting Tier 0 emissions standards (now more than 10 years old), and burning fuels that did not contain ethanol. Because varying levels of ethanol are now being blended into gasoline, emissions data are now needed from vehicles using those fuels.

NREL is now working in collaboration with EPA on this EPAAct Comprehensive Gasoline Light Duty Exhaust Fuel Effects Test Program to cover multiple fuel properties and two ambient test temperatures, which will be referred to hereafter as the "EPAAct Program". The project described in this Statement of Work is designed to fill significant data gaps on the effects of low-level ethanol blends on emissions for the new technology, high mileage and high-emitting vehicles and complements EPA's Contract No.EP-C-07-028, WA0.01:

- Multiple levels of ethanol in gasoline shall be examined in this test program, along with ethanol's interactions with other fuel properties, e.g., volatility and distillation parameters.
- Varying levels of aromatics shall also be evaluated, as they continue to be of interest due to their relationship to emissions of air toxics and the formation of particulate matter in the atmosphere.
- A portion of the tests shall be performed at room temperature and 50°F to fill the gap in the existing data at reduced ambient temperatures.
- Total hydrocarbon (THC), non-methane hydrocarbons (NMHC), non-methane organic gas (NMOG), oxides of nitrogen (NO_x), nitrogen dioxide (NO₂), carbon monoxide (CO), carbon dioxide (CO₂), particulate matter (PM) mass and chemical composition, nitrous oxide (N₂O), ammonia (NH₃) and hydrogen cyanide (HCN) emissions shall be measured in higher mileage and high-emitter vehicles.
- This program will also generate speciated volatile organic compound (SVOC) data. VOC compounds of interest include C₁ – C₁₂ hydrocarbons as well as light alcohols and carbonyl compounds.

2.0 OBJECTIVE

As the second effort in a three-part program, this work covers testing of three vehicles that will be added to Phases 1 and 2 of the base EPAAct Program. In this project, SwRI will perform vehicle recruitment and preparation for two high-emitting and one higher mileage vehicle and perform driving tests to generate analytical data on exhaust gas emissions. SwRI will also generate electronic reports and databases, as well as quality assurance documentation.

3.0 SCOPE OF WORK

SwRI will acquire and test three suitable vehicles in conjunction with Phases 1 and 2 of the EPAAct Program. Additionally, composite exhaust particulate matter (PM) samples will be collected

during EPA-funded testing. These samples will be analyzed for chemical composition of PM and SVOCs. Details of the project are presented below.

3.1 Task 1 -- Work Plan Development

This document represents the detailed work plan, and includes items modified by EPA through Amendment 8 of their Performance Work Statement. In the event that EPA issues additional amendments to the Performance Work Statement, a revision of the overall project schedule and budget may be necessary.

3.2 Task 2 -- Quality Assurance Project Plan and Quality Management Plan (QAPP/QMP)

SwRI has already submitted to EPA a Quality Assurance Project Plan (QAPP) for the EPA Act Program. This QAPP will be modified to incorporate any items that are specific to NREL-funded activities and are not currently covered in the document. The revised QAPP will be submitted to NREL for approval, with input from EPA.

3.3 Task 3 -- Vehicle Recruitment

SwRI will identify and acquire (if necessary) three test vehicles for use in this program. This group of vehicles will be referred to as the "3-vehicle fleet" in order to differentiate them from the 19 vehicles previously procured for EPA (to be referred to as the "19-vehicle fleet"). The 3-vehicle fleet will consist of two high HC-emitting vehicles of different models capable of operation on ethanol-gasoline blends, E0 through E15, and one high-mileage vehicle. It is expected that the high mileage vehicle, with 75,000 to 100,000 miles on the odometer, will be provided by the EPA. As such, this proposal does not include any effort to procure the high-mileage vehicle.

3.3.1 Task 3.1 -- Prepare Two High HC Emitters

Based on discussions among NREL, EPA, and SwRI, it is currently assumed that two high HC-emitting vehicles will come from the EPA Act 19-vehicle fleet, but modified so as to induce high HC emissions. The modifications to each vehicle will be approved by NREL, with input from the EPA, prior to testing.

3.3.2 OPTIONAL Task 3.2 -- Prepare One High HC Emitter & Recruit One "Super-Emitter" (Replaces Task 3.1)

As an option, if requested by NREL, SwRI will recruit one "super emitter" in place of modifying one of the 19 EPA Act vehicles to be a high HC emitter. This vehicle should have a weighted total HC emission rate of approximately six grams/mile over the 3-phase LA92. This vehicle will be inspected and prepared for testing according to the methods outlined in Task 5. The second high HC emitter would be one of the 19 EPA Act vehicles, modified so as to induce high HC emissions. These two test vehicles will be approved by NREL, with input from the EPA, prior to testing. Note that this optional task would be conducted in place of Task 3.1.

3.4 Task 4 -- Test Lubricants

3.4.1 Task 4.1 – 19-Vehicle Fleet

One-ounce samples of lubricant will be collected from each of the 19 vehicles in the base EPAct program immediately prior to their emissions testing (at the end of the mileage accumulation phase (4,000 miles), at the same time engine lubricant samples are taken per EPA Contract No. EP-C-07-028 WA0.01) for the chemical analyses described below. Each of these lubricant samples will be combined into four separate groups for analysis:

- Group A: vehicles 1 through 4
- Group B: vehicles 5 through 8
- Group C: vehicles 9 through 13
- Group D: vehicles 14 through 19

Fuels 17, 18, and 19 will be sampled from the drums containing those fuels, and the lubricating oil samples and fuels will be analyzed separately for the species listed in Section 3.4.2 below.

3.4.2 Task 4.2 – 3-Vehicle Fleet

Engine lubricants for this program have been provided by the EPA. They meet the manufacturer's recommended specifications contained in the owner's manuals. For the 3-vehicle fleet, SwRI will collect a 0.25-quart lubricant sample from each vehicle immediately before its first emissions test in this program and ship half of the sample to the Lubrizol Corporation for analysis:

Lubrizol Corporation
1225 Lloyd Road (Bldg. 8)
Wickliffe, OH 44092
Attn: Dr. Ewa Bardasz

The remaining half of the 0.25-quart lubricant sample and fuel samples from each of the three high emitter/mileage vehicles will be subjected to the following chemical analyses:

SwRI will subcontract Desert Research Institute to perform chemical analyses of the three fuels and the lubrication oils collected from each of the three high emitter/mileage vehicles tested in Phases 1 and 2. The same analyses will be performed on the composited fuel and lubricant samples from the 19-vehicles fleet (one sample each from vehicles 1 through 4; one from vehicles 5 through 8, one from vehicles 9 through 13, and one from vehicles 14 through 19). The species to be analyzed include elements, PAHs, hopanes, steranes and alkanes. The analyses will include alkanes by gas chromatography/ mass spectrometry (GC/MS), to determine PAH, hopanes/steranes. The analytical methods to be used for elemental analysis include X-ray fluorescence (XRF) and inductively coupled plasma-mass spectrometry (ICP-MS). The elements to be analyzed by ICP-MS include aluminum, arsenic, barium, boron, bromine, cadmium, calcium, cerium, chlorine,

chromium, copper, iron, lead, magnesium, manganese, molybdenum, nickel, phosphorus, silver, sulfur, tin, vanadium, and zinc.

SwRI has already procured all three test fuels for Phases 1 and 2 under NREL's Subcontract No. ACI-8-88612-01.

3.5 Task 5 -- Vehicle Preparation (Only Applies to 3-Vehicle Fleet)

The three vehicles to be tested will undergo a thorough inspection before beginning the test preparation sequence. This includes inspection of the engine, transmission, axles, exhaust system and tires, and documentation of OBD2 status. Photographs of the vehicles' exhaust systems shall be taken and included as part of the progress and final reports. SwRI will also collect and record specified vehicle information for entry into EPA's MSOD data tables.

Following the inspection, a single FTP test will be performed on each vehicle using Haltermann Tier 2 EEE certification gasoline with bag measurements of THC, NMHC, NO_x, CO, and PM emissions. The results of this initial test will be submitted to NREL and the EPA for review to determine the vehicle's acceptability as a candidate vehicle for the test program. If accepted by NREL with input from the EPA, an approved candidate vehicle will begin oil conditioning and/or preparations for testing as outlined below.

Each vehicle approved by NREL with input from the EPA will then undergo initial crankcase oil, oil filter, and air filter replacement. Oil and air filters will be procured by SwRI according to manufacturer's recommendations. Engine oil recommended in the owner's manual of each vehicle will be used. If neither of the EPA-supplied lubricants matches the manufacturer's viscosity requirements, the recommended grade of lubricant will be purchased.

For each vehicle, the engine oil and oil filter will be replaced a second time following a full engine warm-up. The lubricant level in the sump will be allowed to stabilize and its level indicated on the dipstick will be recorded. The vehicle will then be driven 2,000 miles on non-oxygenated, commercial, 87-octane gasoline to condition the lubricant in preparation for the emissions test program.

After the last test of each vehicle in the program, SwRI will record the lubricant level indicated on the dipstick before collecting a 0.25-quart oil sample for analysis as described in Task 4, above.

Following mileage accumulation and lubricant conditioning, each new vehicle will once again undergo thorough inspection of the engine, transmission, axles, exhaust system and tires, and documentation of OBD2 status.

If any of the three vehicles is equipped with traction control, SwRI will ensure that the traction control is disabled either through an interior disable button or other method (remove power fuse to anti-lock brake system (ABS)), and place a placard in the vehicle indicating the method of disabling traction control if driver input is required.

For the EPA-provided high-mileage vehicle, chassis dynamometer settings will be derived from target road load coefficients recommended by EPA. The derived chassis dyno settings will be submitted to NREL for approval with input from EPA. The two vehicles modified to be high HC emitters will use the same chassis dynamometer settings derived for the EPA Act Program. Each vehicle will use the same chassis dyno settings during both 75°F and 50°F tests.

3.5.1 OPTIONAL Task 5.1 - "Super Emitter" Chassis Dyno Setup

If Optional Task 3.2 is chosen, chassis dynamometer settings for the "super emitter" will be derived from target road load coefficients as reported in EPA's on-line Test Car List Data Files. Target road load coefficients and subsequently-derived chassis dyno settings will be submitted to NREL for approval, with input from EPA.

3.6 Task 6 - Vehicle Testing

3.6.1 Task 6.1 - Basic Testing Protocol (Only Applies to 3-Vehicle Fleet)

The 3-vehicle fleet will be tested on all test fuels using the California Unified Cycle (LA92). For this program, the LA92 will be conducted as a three-phase, cold-start test in a manner similar to the FTP. Light-duty FTP weighting factors shall be used to calculate composite emissions. Testing will be conducted at two nominal test temperatures: 72°F (Phase 1) and 50°F (Phase 2). All tests on a given vehicle will be conducted using the same 48-inch single roll electric chassis dynamometer. It is expected that a single test site will be used for this entire program. The same driver will be used for all tests on a given vehicle; however, it may be necessary to use more than one driver in the program.

The emission test program shall be executed in the following sequence:

- Phase 1: Fuels 17, 18 and 19 tested in all three vehicles at 72°F
- Phase 2: Fuels 17, 18 and 19 tested in all three vehicles at 50°F

The test fuels shall be tested in each vehicle in the following sequence: Fuel 17 (E0) followed by fuel 18 (E10) and then fuel 19 (E15). It should be noted that this task will not be conducted until all testing of the 19-vehicle fleet is complete. Current estimates are that this task will begin in July 2009.

3.6.1.1 Task 6.1.1 - Phase 1: Testing at 72 °F

Prior to any emission test conducted in this program, the representative bulk oil temperature in the sump will be stabilized within $\pm 3^\circ\text{F}$ of the nominal test temperature. The representative oil temperature is defined in 40 CFR Part 86.232-94. Average intake air temperature and humidity will be maintained at $75\pm 5^\circ\text{F}$ and 75 ± 5 grains $\text{H}_2\text{O}/\text{lb}$ dry air, respectively.

The vehicle test order with each fuel will be randomized. However, replicate tests of a given fuel in a particular vehicle shall be done back-to-back. Specifically, the vehicle will be tested

twice (three times if determined necessary per emissions variability criteria provided in Table 1 below) on a given fuel before moving on to the next test fuel in the matrix.

After two tests have been completed and the acquired data have passed all quality control verifications, the need for a third test will be determined by following the variability criteria shown in Table 1. If the ratio of any of the criteria pollutants (CO₂, NO_x, NMHC) on a pair of tests for a given vehicle/fuel combination exceeds the levels shown in Table 1, a third test will be conducted. NREL and the EPA will be promptly notified, and the electronic summary reports of the tests in question will be made available. The third replicate shall be run the same way as the second, and the second and the third replicates shall be done back-to-back. For budgeting purposes, this proposal assumes that five percent of all test pairs will require a third test. If the actual need to conduct a third test exceeds the five-percent allocation, the project will incur additional costs.

TABLE 1. VARIABILITY CRITERIA FOR TRIPLICATE TESTING

DILUTE GASEOUS EMISSION	CRITERIA FOR REQUIRING A THIRD TEST (COMPOSITE CYCLE EMISSIONS)
CO ₂	Ratio of higher / lower > 1.04
NO _x	Ratio of higher / lower > 1.81
NMHC	Ratio of higher / lower > 1.67

The emissions to be measured and reported are THC, NMHC (by FID), NMOG, NO_x, NO₂, CO, CO₂, light alcohols, ethanol using an INNOVA photoacoustic analyzer, PM, speciated VOCs, N₂O, NH₃ and HCN. More specifically, the following exhaust emission measurements shall be made:

1. Bag (phase) level and composite THC, NMHC, NMOG, CO, CO₂, NO_x, NO₂, ethanol and PM emissions.
2. Bag (phase) level speciated VOCs for a subset of tests (See Task 3.6.2, below). The list of compounds to be measured will be the same as that being used for EPA.
3. Continuous and integrated by bag (phase) emissions of the following species in raw exhaust: THC, NMHC, CO, CO₂ and NO_x.
4. Continuous and integrated by bag (phase) emissions of the following species measured in raw exhaust for a subset of tests (see Section 3.6.4.2, below): N₂O, NH₃ and HCN.

Available data will be acquired from each vehicle's onboard diagnostic (OBD) system during all emissions tests using a DBK70 data acquisition system. Phase level and total test cycle work measured by the chassis dyno will also be determined and reported.

The facilities for testing will meet the requirements of 40 CFR Part 86 Subpart B and 40 CFR Part 86 Subpart C as they apply to vehicle exhaust testing. THC, NMHC, NMOG, NO_x, CO, CO₂, and PM emissions sampling and measurement will be conducted as specified in 40 CFR 1065. If some aspect of testing needs to be done in variance to the above specifications, SwRI will bring

this to the attention of NREL and will describe how such a variance might impact the test results. Variances must be approved NREL and the EPA before testing may begin.

SwRI will follow the fuel change and test execution sequence as described in Table 2, below. In the course of each phase of the EPAct Program, the first two emission tests on a given vehicle and fuel combination shall be performed back-to-back.

TABLE 2. FUEL CHANGE AND TEST EXECUTION SEQUENCE FOR OPTION A

STEP	DESCRIPTION
1	Drain vehicle fuel completely via fuel rail whenever possible
2	Turn vehicle ignition to RUN position for 30 seconds to allow controls to allow fuel level reading to stabilize. Confirm the return of fuel gauge reading to zero
3	Fill fuel tank to 40% with next test fuel in sequence. Fill-up fuel must be less than 50°F.
4	Start vehicle and execute catalyst sulfur removal procedure described in Appendix C of CRC E-60 Program report
5	Drain fuel and refill to 40% with test fuel. Fill-up fuel must be less than 50°F.
6	Allow vehicle to soak at nominal test temperature for at least 12 hours.
7	Start vehicle and drive one LA92 cycle.
8	Move vehicle to soak area without starting or driving
9	Park vehicle in soak area at proper temperature (75 or 50°F) for 12-36 hours
10	Move vehicle to test area without starting engine
11	Perform LA92 cycle emissions test
12	Park vehicle in soak area of proper temperature for 12-36 hours
13	Move vehicle to test area without driving
14	Perform LA92 emissions test
15	Determine whether third replicate is necessary, based on data variability criteria (see Table 2)
16	If a third replicate is required, repeat steps 12, 13 and 14
17	If third replicate is not required, return to step 1 and proceed with next fuel in test sequence

3.6.1.2 Task 6.1.2 - Phase 2: 50°F

The same testing sequence described in Section 3.6.1.1 will also be done at 50°F. It is expected that the average test cell temperature will be maintained at 50±3°F. Test cell humidity setting and tolerance for 50°F will be determined and approved by NREL, with input from EPA, prior to the start of testing at 50°F.

SwRI does not currently have 50°F test facilities in place. However, temporary test cell facilities are being installed in order to accomplish 50°F testing for the EPA-funded portion of the EPAct study. Following EPA-funded 50°F testing of the 19-vehicle fleet, the temporary facilities

will be disassembled and stored until needed for 50°F testing of the 3-vehicle fleet. This proposal includes the effort to reinstall the temporary facilities for testing of the 3-vehicle fleet.

3.6.2 Task 6.2 - Speciation of VOCs (Only Applies to 3-Vehicle Fleet)

Phase-level (bag-by-bag) speciated VOCs will include C₁-C₁₂ hydrocarbons as well as light alcohols, aldehydes, and ketones. Sampling and analysis of C₂-C₁₂ hydrocarbons will be conducted in a manner similar to CARB method 1002/1003, "Procedure for the Determination of C₂-C₁₂ Hydrocarbons in Automotive Exhaust Samples by Gas Chromatography". Sampling and analysis of carbonyl compounds will be conducted in a manner similar to CARB method 1004, "Determination of Aldehyde and Ketone compounds in Automotive Source Samples by High Performance Liquid Chromatography". Analysis of C₁-C₄ HC samples will be done within one hour of completion of the emissions test. Subsequent analysis of the additional compounds of interest will be done within four hours of emission test completion. The time between sample collection and the start of C₁-C₄ HC analysis will be reported. The VOCs to be analyzed are the same as those being provided to the EPA for the EPAAct Project

Sampling and analysis of light alcohols will be accomplished by bubbling exhaust through glass impingers containing deionized water and analyzing samples with a gas chromatograph. Analysis will include the following compounds: methanol, ethanol, isopropanol, n-propanol, and tert-butanol (2-methyl-2-propanol).

The CARB procedure for calculating NMHC and NMOG will be followed. Phase-level NMOG will be calculated for all phases where the required measurements are available (i.e., NMHC, carbonyls, and light alcohol measurements are made). In cases where one or more components of the phase-level NMOG calculation is not measured (for example, when carbonyls are not measurement in Phases 2 and 3 of some tests) phase-level NMOG mass emissions will be calculated by assuming the missing measurements are below method detection limits. These phase-level NMOG calculations will then be used to calculate composite weighted NMOG mass emission rates. In all cases, all measured phase-level NMOG components (i.e., each compound quantified) will be reported separately along with the associated FID response factors used in NMOG and NMHC determination.

3.6.2.1 Task 6.2.1 - Phase 1: 72°F

VOC speciation shall be performed for all three test phases (bags) of the LA92 cycle and on all fuels (three fuels in Phases 1 and 2), for all three vehicles. This includes all repeat tests, and is outlined graphically in Table 3, below.

**TABLE 3. VOC SPECIATION SUMMARY FOR 3-VEHICLE FLEET
IN PROGRAM PHASES 1 AND 2**

LA92 Test Phase (bag)	LA92 Test Repeat		
	Test 1	Test 2	Test 3 (if needed)
Phase 1	C ₁ -C ₁₂ Speciation Light Alcohols Carbonyls	C ₁ -C ₁₂ Speciation Light Alcohols Carbonyls	C ₁ -C ₁₂ Speciation Light Alcohols Carbonyls
Phase 2	C ₁ -C ₁₂ Speciation Light Alcohols Carbonyls	C ₁ -C ₁₂ Speciation Light Alcohols Carbonyls	C ₁ -C ₁₂ Speciation Light Alcohols Carbonyls
Phase 3	C ₁ -C ₁₂ Speciation Light Alcohols Carbonyls	C ₁ -C ₁₂ Speciation Light Alcohols Carbonyls	C ₁ -C ₁₂ Speciation Light Alcohols Carbonyls

3.6.2.2 Task 6.2.2 - Phase 2: 50°F

The same sampling and analysis protocols described in Section 3.6.2.1 will be conducted for all 50°F testing.

3.6.3 Task 6.3 - *Speciated Chemical Analyses of PM and SVOC*

PM and SVOC exhaust samples will be collected and analyzed separately during both Phase 1 and 2 of the EPAct Program. Separate samples sets will be collected for the 19- and 3-vehicle fleets. PM and SVOC samples will be collected over the entire LA92 tests, not by phase (bag). The collection and analyses of PM and SVOC exhaust samples will be as follows:

- PM will be collected on a Teflon filter and quartz filter for mass determination and subsequent chemical analysis. All chemical analyses will be conducted by Desert Research Institute. It is expected that the sampling method will allow for the collection of sufficient sample for the following chemical analyses:
 - Elements, including those that can be used as markers for lubricating oil. The analytical methods to be used for elemental analysis include X-ray fluorescence (XRF) and inductively coupled plasma-mass spectrometry (ICPMS). The elements to be analyzed by ICP-MS include aluminum, arsenic, barium, boron, bromine, cadmium, calcium, cerium, chlorine, chromium, copper, iron, lead, magnesium, manganese, molybdenum, nickel, phosphorus, silver, sulfur, tin, vanadium, and zinc.
 - Hopanes and steranes or other molecular markers that can be used to differentiate fuel and lube oil emission sources.
 - “Elemental” and “organic” carbon (to be analyzed by the TOT and TOR methods); PM soluble organic fraction (SOF), and sulfates.
 - Speciated hydrocarbons will be determined in a manner consistent with what is being used for the Collaborative Lubricating Oil Study on Emissions (CLOSE). This includes PAHs and C₁₄ to C₄₀ alkanes & cycloalkanes by CG/MS.

- Semi-volatile organic constituents (SVOC) will be collected using a polyurethane foam (PUF) and/or Tenax cartridge

3.6.3.1 Task 6.3.1 - 19-Vehicle Fleet

For each of the three test fuels, four composite sample sets will be collected while testing the 19-vehicle fleet.

3.6.3.1.1 Task 6.3.1.1 - Phase 1: 72°F

Composite PM and SVOC samples will be collected from all test runs on all three fuels tested at 72°F, including replicates. Samples will be composited for each fuel as follows:

- A: vehicles 1 through 4
- B: vehicles 5 through 8
- C: vehicles 9 through 13
- D: vehicles 14 through 19

The total number of composite PM and SVOC samples will be 4 samples \times 3 fuels for a total of 12 composited samples.

3.6.3.1.1.1 OPTIONAL Task 6.3.1.1.1 – Phase 1 Random Test Order

It is expected that EPA will require a unique random order for testing the 19-vehicle fleet on each of the three fuels. If this is the case, then additional effort will be required during testing of Fuels 18 and 19 in order to collect composite samples A through D from the same vehicles as with Fuel 17. Four separate filter holder sets will be utilized for sample sets A through D, and will be changed out in between tests.

3.6.3.1.2 Task 6.3.1.2 - Phase 2: 50°F

Composite PM and SVOC samples will be collected in the same manner as given above in Section 3.6.3.1.1. The total number of composite PM and SVOC samples will be 4 samples \times 3 fuels for a total of 12 composited samples.

3.6.3.1.1.2 OPTIONAL Task 6.3.1.1.2 – Phase 2 Random Test Order

This task will be conducted in the same manner as Task 6.3.1.1.1 given in Section 3.6.3.1.1.1 above.

3.6.3.2 Task 6.3.2 - 3-Vehicle Fleet

For both Phases 1 and 2, the PM and SVOC samples will be composited for all three phases of the LA92 cycle, for all the replicate tests (two or three, as deemed appropriate according to the criteria in Table 1 above) for each of the three vehicles on each of the three test fuels.

3.6.3.2.1 Task 6.3.2.1 - Phase 1: 72°F

The total number of composite PM and SVOC samples will be 3 samples \times 3 fuels for a total of 9 composited samples.

3.6.3.2.1.1 OPTIONAL Task 6.3.2.1.1 - Real-Time Particle Count by EEPS

As an optional item, real-time particle size and number count will be measured using the TSI Engine Exhaust Particle Sizer (EEPS). The EEPS measures particle number and size distribution in real time every 100 milliseconds covering a size range from 5.6 nm to 560 nm. This size range represents more than 99 percent of particle number emitted from combustion sources. Results will be reported for each run from each vehicle and fuel.

3.6.3.2.2 Task 6.3.2.2 - Phase 2: 50°F

Composite PM and SVOC samples will be collected in the same manner as given above in Section 3.6.3.2.1. The total number of composite PM and SVOC samples will be 3 samples \times 3 fuels for a total of 3 composited samples.

3.6.3.2.2.1 OPTIONAL Task 6.3.2.2.1 - real-time particle count by EEPS

If selected, this optional task will be conducted in the same manner as Task 6.3.2.1.1, as given in Section 3.6.3.2.1.1 above.

3.6.4 Task 6.4 - Measurement of Gaseous Exhaust in Raw Emissions (Only Applies to 3-Vehicle Fleet)

3.6.4.1 Task 6.4.1 - Continuous THC, NMHC, CO, CO₂, and NO_x

3.6.4.1.1 Task 6.4.1.1 - Phase 1: 72°F

Continuous emissions of THC, NMHC, CO, CO₂ and NO_x will be measured in raw exhaust of the three high emitter/mileage vehicles. These measurements will be made at the tailpipe position only. The continuous measurements will be made at a sampling frequency of 1 Hz. A SEMTECH EFM will be used to make a direct raw exhaust flow measurement.

3.6.4.1.2 Task 6.4.1.2 - Phase 2: 50°F

This task will be conducted in the same manner as listed for Task 6.4.1.1 in Section 3.6.4.1.1 above.

3.6.4.2 Task 6.4.2 - Continuous N₂O, NH₃, and HCN

3.6.4.2.1 Task 6.4.2.1 - Phase 1: 72°F

Continuous and phase-integrated emissions of N₂O, NH₃ and HCN will be measured from the three high emitter/mileage vehicles using Fourier Transform Infrared Spectroscopy (FTIR). These measurements will only be taken during the first test of each fuel/vehicle combination and no repeat measurements will be conducted.

3.6.4.2.2 Task 6.4.2.2 - Phase 2: 50°F

This task will be conducted in the same manner as listed for Task 6.4.1.1 in Section 3.6.4.2.1 above.

4.0 REPORTING AND DELIVERABLES

4.1 Weekly Reports

SwRI will conduct weekly telephone conference calls with NREL and EPA unless otherwise directed. The meetings are for the purpose of monitoring the project and addressing issues as they arise. These weekly calls are currently scheduled for Tuesday mornings at 10AM Eastern / 9AM Central / 8AM Mountain.

4.2 Monthly Written Progress Reports

SwRI will provide monthly progress reports. Invoices will be provided on four-week intervals corresponding to SwRI accounting periods. Progress reports will describe the level of effort used in Phases 1 and 2 and whether the project is on schedule. SwRI will explain any problems encountered including resolutions and indicate if the schedule or budget was compromised.

The reports will summarize the progress made during the reporting month, technical issues encountered, solutions to issues (proposed or attempted), and projected activity in the following month. Graphical presentations shall be made to display results if data have been collected.

4.3 Data Files

SwRI will submit the data to NREL and EPA in three formats, each format having different levels of post processing and aggregation. The files are nominally:

1. Non-Post processed data files (raw data): These are the native test level data files, usually generated by instrumentation, that have not been post-processed for such purposes as time-series alignment or calculation of continuous emission rates. They will be submitted to EPA as a deliverable for this work assignment and labeled using the following convention:

‘e’<*VehID*>_<*fuelID*>_raw.<*extension*>

where *VehID* is the unique identifier designated for vehicle, *fuelID* is the unique identifier assigned to each fuel type, and *extension* is the appropriate file extension for the file’s data format. Modifications to the specified file-naming convention may be adopted following approval from the EPA Work Assignment Manager.

2. Post processed data files: These are the minimally processed test level data files that will contain the composite, test level, bag level, and one Hertz (modal) emission rates in the units specified in 40 CFR Part 86. They will be submitted to EPA as a deliverable for this work assignment and labeled using the following convention:

‘e’<*VehID*>_<*fuelID*>_pst.<*extension*>

where *VehID* is the unique identifier designated for vehicle, *fuelID* is the unique identifier assigned to each fuel type, and *extension* is the appropriate file extension for the file’s data format. Modifications to the specified file-naming convention may be adopted following approval from the EPA WAM.

3. SwRI will also deliver Mobile Source Observation Database (MSOD) input data files containing test results and vehicle information using table names, structures, field names and field formats as specified in Appendix C of the Statement of Work. During the program it may be necessary to design and apply new data types, tables and structures. As necessary, such modifications to the data structure would be approved by the EPA WAM.

4.4 Mode of Delivery

SwRI will deliver one set of files to NREL and the USEPA National Vehicle and Fuel Emissions Laboratory at Ann Arbor, Michigan. Data contained in the MSOD formatted tables will be made available on a secure ftp site. Under no circumstances will these files be delivered by insecure methods such as electronic mail attachments or First Class Mail.

4.5 Draft Final Report

SwRI will submit a draft final report to NREL and the EPA that details the work completed including any issues encountered and results from Phases 1 and 2. The draft report will include:

- Recruitment procedures
- Vehicle-related information, VIN, mileage, emission system descriptions, etc.
- Measurement methodologies and quality measures

- Test completion diary for individual vehicles detailing any relevant information regarding completion of each test
- All data collected in Tasks 1 through 3 of this subcontract. Graphical displays summarizing the data by fuel type and other relevant breakdowns

The draft final report shall be delivered to NREL and the EPA within six weeks of the testing completion.

4.6 Final Report

SwRI will provide a final report incorporating NREL and EPA comments, within 30 days of receiving comments from NREL and EPA. The report will be in hard copy plus an agreed-upon electronic format such as Microsoft Word or Adobe portable document files (*.pdf). Reports shall be delivered both to NREL and the EPA. The EPA contract in effect is EP-C-07-028, WA 0.01.

5.0 PRICE AND SCHEDULE

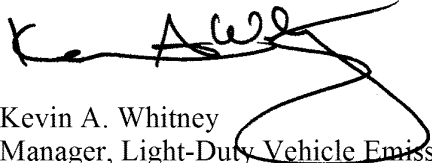
The price and estimated schedule of each task and/or subtask is given below in Table 4. If all optional tasks are chosen, the price would be **Ex. 4 - CBI**. Detailed pricing information is included in Appendix A.

Ex. 4 - CBI

6.0 CLOSURE

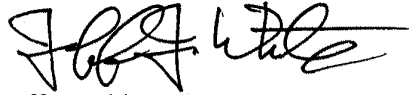
If you have any technical questions please contact Kevin Whitney at (210) 522-5869 or by email at kwhitney@swri.org. Questions of a contractual nature should be directed to Sherry Twilligear at (210) 522-3948 or by email at sheryl.twilligear@swri.org.

Prepared by:



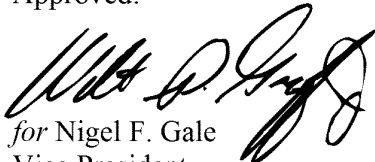
Kevin A. Whitney
Manager, Light-Duty Vehicle Emissions
Department of Emissions Research and
Development

Reviewed:



Jeff J. White
Director, Department of Emissions Research
and Development
Engine, Emissions and Vehicle Research
Division

Approved:



for Nigel F. Gale
Vice President
Engine, Emissions and Vehicle Research Division
Office of Automotive Engineering

/tyd

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c: Ms. Sherry Twilligear, SwRI Contracts

APPENDIX A

COST DETAIL

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